The observed and calculated positions agree only in the limits of the errors of observations on the assumption "of a periodic term, the period of which is nearly identical with that of the lunar period, and whose maxima and minima occur at epochs when the longitude of the moon differs by 90° from that of the planet. Adopting 6″·40 in place of 6″·50 for the lunar equation, the residuals obtained from the corrected ephemeris and the observations are made very small, as can be seen from the last two columns of the above table.

The correction of −0″·1 in the lunar equation demonstrates, as Dr. Gill says, that the value adopted up to the present for the lunar mass ought to be diminished by one-hundredth.

DIFFERENCE OF LONGITUDE BETWEEN VIENNA AND GREENWICH.—In the fourth volume of the "Publicationem für die Internationale Erdmessung," entitled "Astronomische Arbeiten des k.k. Gradmessungs-Bureau," by Theodor v. Oppolzer, and after his death by Prof. Weiss and Dr. Robert Schram, we are presented with the results of the determination of the difference of longitude between Vienna and Greenwich, and with the Berlin time determinations and the personal equations of the separate observers relating to other longitude determinations, those between Vienna—Berlin—München—Greenwich. We may mention here that, with regard to the first-mentioned determination, another one, between the same places but after a method due to Döllen, by observations in the vertical of Polaris, will appear in a later volume.

The observations for the combined longitude determination between the above-mentioned places were commenced on July 7, 1876, and were completed on September 26 of the same year. Not only was the usual method of procedure adopted, but also that which we owe to Döllen, the instruments used being, for the former method those by Repsold, and for the latter those by Herbst. In the Vienna—Greenwich longitude determination at the beginning and at the end of the observations, time signals, both from Vienna and from Greenwich, were changed with Berlin; in the middle observations Vienna—Greenwich interchanged time signals; and towards the end München was included. In the following table, which gives the results for the single evenings, ΔL represents the longitude between the points of observation and *d*ΔL the deviations from the most probable value of the longitude difference:—

Date.		ΔL. h. m. s.		*d*ΔL. s.
17 July, 1876	...	1 5 21·037	...	+0·043
21 ,,	...	21·028	..	+0·034
22 ,,	...	20·995	...	+0·001
26 ,,	...	20·955	...	−0·039
5 Aug.	...	20·832	...	−0·162
7 ,,	...	21·107	...	+0·113
17 ,,	...	21·146	...	+0·152
21 ,,	...	20·845	...	−0·149
27 ,,	...	21·016	...	+0·022
5 Sept.	...	21·037	...	+0·043
11 ,,	...	21·025	...	+0·031
21 ,,	...	1 5 20·902	...	−0·092

The result obtained, when the points of observations are reduced respectively to the centre of the Greenwich Transit Circle and to the centre of the large dome of the Vienna Observatory is

1h. 5m. 21·421s. ± 0·021s.

PHOTOGRAPHS OF THE MILKY WAY.—Prof. E. E. Barnard, who has recently been on a visit to Europe, has brought with him some wonderful photographs of the Milky Way, which are simply a revelation to many of us. These photographs (*The Observatory*, No. 203) were taken at the Lick Observatory with a lens made by Mr. Willard of New York in 1859, which is one of large aperture (6 inches) and short focus (31 inches). Such a lens tends to compress as well as intensify the characteristic features of these stellar clouds, the large field allowing one to embrace any of these forms as a whole, and not in detail, as is the case when they are viewed with a telescope. The first photographs, showing the cloud forms, were taken in August of 1890, the portion of the sky being that situated in Sagittarius, and the exposure 3h. 15m. A most interesting picture is that of a section of the constellation of Cygnus, near γ Cygni; this photograph shows some of those curious and almost weird dark spots and dark lanes the origins of which are very doubtful. Mr. Ranyard supposes them to be due to an obscuring medium between us and that part of the Milky Way, but Prof. Barnard's opinion is that they are real holes in the cloud structures themselves. Two photographs with different lengths of exposures (2h. 45m. and 4h. 30m.) of the region about M. 11 in the constellation of Sobeski raises an important point as regards the different structure of the Milky Way. The second picture exhibits details which considerably altered the configuration, not at all brought out in the first one. Not only in these photographs, but in several others of the Milky Way, this fact has been noticed, and Prof. Barnard suggests that there may be different orders or kinds of cloud structure implying distance or nearness, or possibly an entirely different order of stars in point of actual size.

THE INSTITUTION OF NAVAL ARCHITECTS.

THE summer meeting of the Institution of Naval Architects was held last week in Cardiff. This is only the fifth provincial meeting held by this Society since its foundation. The first was in Glasgow, the next in Liverpool, and the third in Newcastle. The fourth was held again in Glasgow. All these meetings were eminently successful, and it is somewat strange that the Council should not have made a point of holding a country meeting every year. We believe, however, that it is now the intention to follow that course, and certainly the great success of the meeting held in South Wales last week will support those who advocate two meetings a year.

We propose in our report dealing only with the sittings held for the reading and discussion of papers, but it may be stated that the excursions were very successful. Some of these were of a purely recreative nature, such for instance as that which occupied the whole of the last day, Friday, the 14th inst., when members were taken from Cardiff to Ilfracombe and back by the steamer *Lorna Doone*. The visit to Caerphilly Castle, with the luncheon in the ancient banqueting hall, could not by any means be construed as "business" for naval architects, and the same might be said of the visit to Lord Windsor's grounds at Penarth, illuminated for the occasion.

Mixed with these junkettings, however, there was a good deal of a more serious nature, as the following list of papers read will show:—

(1) "On points of interest in the construction and repair of vessels carrying oil in bulk," by B. Martell, chief-surveyor of Lloyd's Registry of Shipping.

(2) "On fast ocean steamships," by F. Elgar.

(3) Some experiments on the combination of induced draught and shot air, applied to marine boilers fitted with serve tubes and retarders," by J. D. Ellis.

(4) "On wear and tear in ballast tanks," by A. K. Hamilton, of Lloyd's Registry.

(5) "On the transmission of heat through boiler plates," by A. Blechynden, Barrow.

(6) "On water tube boilers," by J. T. Milton, chief-engineer-surveyor to Lloyd's Registry.

(7) "On the theory of thin plating and its applicability to calculations of the strength of bulkhead plating and similar structures," by G. H. Bryan, of Cambridge.

The last paper was not read, but distributed at the meeting, the discussion being deferred until the spring meeting of next year.

On the members assembling at the Town Hall, Cardiff, on the morning of Tuesday, the 11th inst., they were welcomed by the Mayor of Cardiff, and the chair was then taken by Sir Nathaniel Barnaby (late Director of Naval Construction), the President, Lord Brassey, not having arrived. Mr. Martell's paper dealt with various details involved in the construction of oil tank steamers. It would seem at first sight a simple matter to construct a steel vessel capable of carrying oil in bulk; but this is by no means the case, and in trying to solve the problem involved naval architects have been met by some altogether novel problems. One of these is the arrangement of riveting, and with this feature the author dealt at some length, going into details in the thorough manner which his unique position enabled him to do. Without diagrams it would be impossible to follow the author in his various lines of reasoning, more especially in the matter of arrangement of tanks, the disposition of stringers, brackets, and other parts of a ship's structure. We will therefore refer those of our readers interested in this matter to the Transactions of the Institution for details, which were fully set forth by the author.

Dr. Elgar's paper was largely of an historical nature. The author, who was until lately the Director of Dockyards, is now the chief technical and scientific adviser to the Fairfield Shipbuilding Company of Glasgow, the largest shipbuilding corporation in the world. This firm has recently constructed the Atlantic liners *Campania* and *Lucania*, at present the biggest ships afloat. The paper drew a comparison between the *Great Eastern* and these modern vessels, which more nearly approach in size the monster ship of nearly forty years ago than any vessels ever constructed. The following table is interesting as drawing a comparison between the past and present :—

	Great Eastern.		*Campania.*	
	ft.	in.	ft.	in.
Length over all	692	0	622	0
Breadth moulded	82	2	65	0
Depth moulded to upper deck	58	0	41	6
Load draught	30	0	27	0
Indicated horse power ...	8,000		30,000	
Gross register tonnage ...	18,915 tons		12,950 tons	
	Knots.		Knots.	
Speed at sea (full power) ...	14 to 14½		22 to 23	

These figures show at once the advance in marine science and the extent to which the past naval architects more than anticipated the work we have yet done in the size of ships built ; and it must be confessed the honours appear to rest with the engineer. The *Great Eastern* was fitted with both screw and paddle wheels, an arrangement which proved a costly mistake. It should be said, however, that the marine engineer has an almost unlimited field for the exercise of his ingenuity, whilst the naval architect is fettered and bound in the most vital element of design, namely, the draught of water. It is useless to build a ship which can never enter the great ports of the world, and here we have reached a limit of 27 feet. The ship designer waits for the civil engineer to improve the chief harbours of nations before he can exercise to the full the resources which modern science has otherwise placed at his disposal. An addition of another 5 feet to the depth of some of the chief commercial ports would mean an advance in ship construction before which the growth of the last twenty years, great as it is, would be far eclipsed. For this reason it is likely that the bulk of the *Great Eastern* will be unapproached for very many years. Her length, great as it was, was a smaller proportion to her breadth than in modern ships, and to equal her displacement on the proportions of beam and length which are now considered desirable, a modern ship would require to be considerably longer than was the wonderful craft which was the embodiment of such high ambition forty years ago, and which found her most profitable employment in her last days as a show for trippers to the Liverpool exhibition.

Mr. Ellis described in his paper trials made at the steel works of John Brown and Co., of Sheffield, to show the advantage of a combination of features which the author considers desirable in the generation of steam. He uses induced draught, heating of the air supplied for combustion, and Serve boiler tubes. We have never been able to see what ground the supporters of induced draught have for claiming the great virtues supposed to exist in drawing the air through the furnace by means of a fan in the chimney, rather than driving it through by a fan in the stokehole. It is easier to grasp the advantages of heating the air supplied for combustion, supposing it is done by heat that would otherwise be wasted, but it is an open question whether this regenerative process could not be beneficially replaced by heating the feed water to be supplied to the boiler. It is certain that heat from the waste gases or products of combustion will be more readily absorbed by water than by air. In regard to the part of the system involved in the use of Serve tubes, there is perhaps less room for doubt as to the advantages to be reaped. The Serve tube may be described as an ordinary boiler tube, having on its interior a number of metal ribs which are formed in one with the tube itself. The object of these is to penetrate the stream of hot gases, often flame, passing from the furnace to the chimney, and thus act as collectors for the heat to be transferred ultimately to the water in the boiler. The principle may be described as that of the Constantine stove inverted. The device appears logical and we can accept the statement that whatever heat is taken up by the metal is readily transferred to water surrounding the tubes ; or, as one speaker during the discussion put the matter, "if we look after the absorbing surface, we know the distributing surface will look after itself." That is true so long as the distributing surface is clean, but it is to be feared such a desirable state of things is not often present in steam boilers. Later in the meeting Mr. Blechynden, in his paper, pointed out how even wiping a plate surface with greasy waste on the water side caused the rate of transmission of heat to fall off, and Mr. Durston some months back told us how bad is the inner side of tubes and plates in a marine boiler. However, the Serve tubes appear to have made a favourable impression upon engineers in spite of the difficulties in the way of sweeping, &c., which threatened them at first. The problem of their introduction appears largely to have established itself on a commercial basis. In the tables attached to his paper Mr. Ellis gave details of the trials made. From 10¼ to 10½ lbs. of water were evaporated per lb. of coal from and at 212° Fahr., burning 40 to 45 lbs. of coal per square foot of grate per hour. The temperature of the gases in the smoke box was from 653 to 692° Fahr., whilst after passing through the apparatus used for transferring the heat of the gases to the air supplied for combustion the chimney gases, 386 to 391° Fahr., the difference between the two representing the arrestation of heat units by the regenerative apparatus, less accidental loss. An analysis of the chimney gases would form a valuable addition to these details, as was pointed out at the meeting. In any case, however, the boiler tested had a much better chance at Messrs. Brown's works than it would have had on ship-board ; nevertheless, the results may be said to be encouraging.

Mr. Hamilton's paper on wear and tear in water-ballast tanks was of a very special character, although a most important matter to shipowners. The moral of his investigations may be summed up in keeping boilers well off the bottom, filling tanks right up, and applying good paint properly at sufficient intervals. If it could be managed to thoroughly dry the tanks when empty it would be of more importance than anything else, but it is difficult to see how this is to be done.

Mr. Blechynden's paper was also of a special character, and gave the results of some very pretty experiments made to determine the problem referred to in the title of his paper. It would be difficult, without illustrations, to describe the experiments, but the broad general fact brought to light was, as the author stated, "that the units of heat transmitted through any of the plates per degree of temperature between the fire and water are proportional to the difference." The inference might be also drawn from the results that the steel plates lowest in carbon were also lowest in conductivity ; but the experiments, as the author said, should be extended to confirm this.

Mr. Milton's paper on water-tube boilers dealt with the subject of the hour, at any rate from a marine engineer's point of view. The paper described the most prominent types of water-tube boiler now on trial before the engineering world. By the triple and quadruple compound engine we have placed the motor so far ahead of the steam generators that marine engineers must perforce turn their attention to the first source of power on board ship. The introduction of corrugated furnaces gave the boiler a considerable step in advance, and, together with the use of steel as a material for construction, made the advances in marine engineering so well illustrated by Dr. Elgar's comparison of the *Great Eastern* and *Campania*, at all possible. Leaky tubes, however, have set us all back again, and the conviction is growing among engineers that an entirely new departure is required in boiler design. The only thing that offers is the water-tube system, in which steam is generated in a series of pipes containing water and surrounded by hot gases, rather than in a cylindrical shell through which tubes run to convey the products of combustion through their interior from the furnace to the chimney. The water-tube boiler is almost as old as the more ordinary multi-tube (fire-tube) boiler ; but unhappily the lamentable failures of a generation ago—in which several lives were lost—threw such discredit on the system that it has been tabooed ever since. We are now beginning to see how to get over the errors of the past, and the great feature now to be solved is the question of durability. That can only be settled by time ; and it seems possible that the water-tube boiler may creep from smaller to larger vessels until the shell boiler becomes a thing of the past on shipboard ; at least that is the opinion of some marine engineers whose word is entitled to the highest respect. Possibly in the meantime a practical way may be found of generating power in the motor itself without the intervention of steam and the apparatus for generating it. Before that time arrives, and some form of gas engine (including oil engines) arrive, a distinctly new departure will have to be made equivalent to that of the separate condenser of Watt.

The last paper in the list, that of Mr. G. H. Bryan on bulkheads, was in some respects the most promising and most suggestive of the meeting. The bulkhead question has been troubling the most thoughtful of our naval architects for some time past. Dr. Elgar attacked the question some time back in a paper he read before the Institution, and Mr. Martell also read a memoir on the subject. Some time ago a strong Government committee was appointed to consider the problems involved in this matter, and a report was issued. Rightly or wrongly, some naval architects are not satisfied with the position in which the report left the question. It is considered by many of the more thoughtful that a more scientific method of dealing with the problem should be evolved. Mr. Bryan, who is a Cambridge mathematician of high reputation at his University, has been led to take the matter up, and the present paper is an effort to bring higher mathematics to the aid of the solution of the question. The paper, however, contains nothing that need appal any naval architect or engineer who can lay fair claim to the title, and it is eminently practical. The similes selected by the author are of the simplest nature; indeed, the memoir reads more like a contribution from the pen of the late Mr. Froude, who was a very prince of lucidity and simplicity. We are reluctantly obliged, through want of space, to treat this paper as we have the others read at this meeting, and only give a suggestion of its scope, referring our readers to the Transactions of the Institution for fuller details. Mr. Bryan attacks the theory, still held by many engineers, that the plate may be regarded as consisting of a series of parallel strips supporting pressure by their tensions. Euler's and Bernouilli's early theories have been abandoned by mathematicians, and Mr. Bryan is now trying to persuade engineers to do the same in effect in giving up the "parallel strip" illustration. The matter affords an excellent example of the manner in which the student of higher mathematics may assist the engineer. We may add that it is proposed to discuss the subject at the next meeting of the Institution to be held next spring, and doubtless Mr. Holmes, the secretary of the Institution, would forward a copy of the paper to any one wishing to take part in the discussion. The address of the Institution is 5, Adelphi Terrace, Strand.

SOCIETY OF CHEMICAL INDUSTRY.

THE Annual General Meeting of the Society of Chemical Industry was opened at University College, Liverpool, on July 12, when Sir John Evans, K.C.B., Treas. R.S., delivered his Presidential address as follows:—

"When I look at the list of those who in past years have occupied the Presidential chair of this Society, all of them men eminent in the departments of either theoretical or practical chemistry, or, indeed, of both, I cannot but feel my own insufficiency to succeed them in worthily fulfilling the duties of this post. I am, indeed, tempted to inquire how and why it was, that, in accordance with the pressing invitation of some members of the Council, I ever consented to allow myself to be placed in nomination as your President. It certainly was not on the grounds of any fancied chemical attainments; nor was it from my having been in former years associated with any industry that is usually regarded as being specially connected with chemistry. Far less was it in the hope that any remarks that I might be called upon to make while acting as your President could be of any particular interest or value to those who, in all probability, are far better acquainted than I can pretend to be with any subject that properly comes within the scope of such a Society as ours. I believe, however, that the main reason that I had for allowing myself to be brought forward is one that will, to a great extent, palliate my shortcomings in so many of the essential requisites for such an office. It was the hearty and entire appreciation that I felt of the work and aims of such a Society as that of Chemical Industry, that was the prime mover in the case. Whether I regarded the organisation of the Society, with its sections at all the principal centres of chemical operations, each to a certain extent independent, but all working harmoniously together, and forming one powerful and important body, with high objects and aspirations before it; or whether I looked at it as presenting a bond of union between industries apparently unconnected, while, at the same time, furnishing information of the most useful character to each and all, I could not but recognise it as a body in the highest degree conducive to the public welfare; so that on these, if on no other grounds, I should have been wanting in public spirit had I stood aloof when others urged me to accept the post of your President.

"It is, I firmly believe, only by some such cordial co-operation among the different industries of this country as that which our Society has inaugurated, that the commercial position of Great, or Greater, Britain is to be maintained; and the more fully the interdependence between one branch of manufacture and another is recognised and acted upon, the more likely are we, as a whole, to maintain our place in the keen race of competition with other countries.

"A merely cursory glance at our Journal will at once show how numerous are the departments of British industry that are more or less dependent on chemical knowledge, the information given on current literature and the specifications of new patents being arranged under no less than three-and-twenty different heads, many of them embracing several varying occupations. Not a few of these headings would, within my own memory, have conveyed but little meaning even to experts. I need merely carry back the minds of some of the elder members of the Society, not only to the days when aniline colours were not and Dr. Perkins was comparatively unknown, but to the time when lucifer matches had not been invented, when photography was practically non-existent, and when in most of those industries in which a knowledge of chemistry is now regarded as indispensable, the 'rule of thumb' reigned absolute.

"I can speak of those old times with some personal feeling, as it is now upwards of fifty years since, that having presumably completed my education, I first entered a paper-mill in order to learn the art and mystery of the manufacture of paper, with which the name of the firm of which I was until lately a member—that of John Dickinson and Co.—has been so long, and, I may venture to say, so honourably connected. It was, of course, recognised that some knowledge of chemistry was a requisite in such a manufacture, but I must freely confess that our methods were of the rudest, and that it was only as years rolled on, and first esparto fibre, and then the different kinds of wood pulp were introduced into the manufacture, and the various methods and results of sizing studied, that a thorough acquaintance with chemical laws became a *sine qua non* for those who hoped for success in this branch of industry.

"At the date that I have in view—say 1840—although rags were the staple material for the manufacture of paper, our consumption of them was but small, and they were principally used by us in producing paper for copper-plate work—steel plates at that time being rarely used—and for the highest class of printing papers. We consumed, however, a large quantity of raw material in the shape of the waste arising in the manufacture of linen and cotton goods, and we had collecting agents at Dundee, Belfast, Bradford, Leeds, and Manchester, who bought the waste upon the spot. At Manchester we had a mill, in which the cotton-waste was cleaned, boiled, and converted into what is known as 'half-stuff,' which was finally bleached and made into paper at our Hertfordshire mills. In that county we had another 'half-stuff' mill, at Rickmansworth, where the linen waste was treated. The boiling was carried on in open keirs, or such as were partially closed, and always at a low pressure, as high pressure boilers for such materials were practically unknown. Most of the waste was twice boiled, first with caustic lime, and secondly with a small amount of soda. The 'shieves,' or woody particles, that were unreduced by the boiling, were got rid of by a long process of screening, or 'devilling,' after the 'half-stuff' had been dried so far as possible in hydraulic presses. The material was then bleached in stone chambers by the direct action of chlorine gas, produced on the spot in retorts. At the mills, however, where the 'half-stuff' was converted into paper, the remains of the chlorine had to be washed out, and the final bleaching of the stuff to be effected with bleaching salts. No process for the recovery of the soda used in boiling was then known, and, indeed, the quantity used was so much less than that which is now necessary with esparto, that it would not have paid to recover it. I remember, however, being engaged in some experiments for the recovery of the manganese from the spent liquor of the retorts. Even when first Mr. Routledge introduced the use of esparto fibre no evaporating or recovery